UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Agricultural Engineering
S. H. McCrory, Chief

DRIERS FOR SEED-COTTON

By

Charles A. Bennett,
Associate Mechanical Engineer

September, 1931

United States Department of Agriculture

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In 1926 the Bureau of Agricultural Engineering[1/] began a series of investigations intended to develop simple and practicable means for drying damp seed-cotton so as to make ginning an easier and simpler process. This pamphlet describes the kinds of horizontal and vertical driers which the Bureau has tested and found practicable to build at the cotton gin or on the plantation for efficient and economical drying of seed-cotton.

"The Government Process"

As a result of the investigations the Bureau has developed and patented a process, which has come to be somewhat generally known as "the Government process", for use with several types of apparatus. The process meets the special requirements for drying seed-cotton, and is adapted to all of the existing successful cotton-drying equipment. It is suited to seed-cotton only and is not intended for drying hay or grain. It involves the following features:

1. The damp seed-cotton is treated with a continuous current of hot air, at the rate of from 40 to 100 cubic feet of hot air for each pound of damp seed-cotton.

2. The damp seed-cotton is exposed to the drying process for a period of from 45 seconds to 3 minutes; from 1 to 2 minutes is recommended.

3. The temperature of the drying air should be not more than 200° F. Satisfactory working limits of temperature are from 160° to 200° F. Above 200° the cotton fiber may be baked and spiralized; below this limit no damage is known to have resulted from exposures of 3 minutes or less.

1/ Up to June 30, 1931, the agricultural engineering activities of the Department of Agriculture were organized as a division in the Bureau of Public Roads.

Types of Driers Developed

As a result of the experiences with driers gained from 1927 to 1930, an improved horizontal drier and a simple vertical drier have been developed, both of which may be homemade as herein described. Either type can handle 4 or more bales of damp seed-cotton per hour, which is sufficient for a 4 - 80 gin. The driers may be operated in any kind of weather, provided the dried cotton is conveyed directly to the gins in the heated air.

The horizontal drier, shown in Figure 1, will handle cotton that is too damp to be dried in the vertical drier. Even rain-soaked cotton can usually be dried in one passage through the drier.

The vertical drier, shown diagrammatically in Figure 9, will serve for drying cotton which does not contain an extraordinary amount of moisture. There are no moving parts in this drying chamber. The drier can be quickly cleaned, which is a convenience where the cotton seed is to be saved for planting. It can be built cheaply, requires little attention, and has long life.

The funnel at the outlet of either drier should be connected by a pipe to the ginning system so that the cotton may be conducted to the cleaners or distributors in an envelope of hot air. This will prevent dampening of the cotton after drying, even on rainy days. The piping may be so arranged that the cotton can be passed directly to the overflow of the gin and from there returned to the drier. By this arrangement the vertical drier can be made to handle cotton of almost any degree of dampness.

The following pages give details and descriptions of each type of drier so they can be constructed by the class of labor ordinarily available about cotton gins or plantations.

Either drier may be installed within the gin building. The horizontal drier may be equipped with or without legs so that it may be placed on the floor or overhead. The vertical drier may be placed outside the building, since its frame can be made to include boiler space, etc. under the separator and fans, enabling it to deliver dried cotton to either a wagon or the gin.

Construction of Horizontal Drier

Figures 1 to 8 give the details for a horizontal 4-floor drier, except for boiler and piping which must be arranged to suit the kind of blast coil or steam radiator used.

Drying Cabinet. (Refer to Figs. 1, 2, 3, 4 and 7.)- For most needs, a 4-floor drier of 24-foot length is sufficient, (fig. 1), but a 32-foot length — or even a 6-floor, 32-foot drier-- may be needed in some sections of the cotton belt. The floors are spaced 15 inches apart, ending 4 feet from the drop-off end. Each skeleton conveyor cares for two floors, starting its return passage beneath the return shelf as shown. The return shelves are built into the cabinet, and the canvas flaps are nailed to the edges of the shelves and to the sides of the cabinet so that they form rectangular flap valves. The conveyor passes beneath this flap valve.

The skeleton conveyor is made of No. 77 detachable chain such as link-belt or chain-belt, with D-5 right and left-hand attachments (fig. 2) spaced about one foot (7 links) apart. Pieces of common 1/2-inch black iron pipe, without threads or rivets, slip freely onto these attachments and form the drag bars or cotton carriers.

To prevent machining and rubbing the cotton, these carriers must be held about 3/8-inch above the floors. This is done by using a 3 x 2 x 3/16-inch angle-iron chain rail at each side of the cabinet. These angles are stock materials and should be purchased with countersunk nail-holes on their inside faces, so that they can be nailed in place to the sills and sides of the drier. Figure 2 shows these angles and the conveyor.

Figures 3 and 4 give framing details for the cabinet, with and without legs. The floors of the cabinet are shown as No. 22 galvanized iron, but No. 28 is used for lining the side and end walls, to lower the cost. The floor sheets should be purchased in the standard 48 by 120-inch stock sizes, so that little or no sheet-metal work is needed. A lap of at least 1 inch should be made where the sheets join. This joint should be soldered smoothly rather than nailed.

Figure 5 gives shop details of the sprockets and shafting. It is advisable that the sprocket and shaft assemblies be bought from a regular machinery house.

A 1-inch steam line from the boiler should be connected to each floor of the cabinet, with one control valve. This makes a first-class fire extinguisher.

Feeding Equipment.-The drier requires a telescope, a separator, and an unloading fan. These may be new or second-hand. A telescope of about 11-inch size is suggested, to prevent too rapid feeding or "hogging" of the damp cotton. The separator should be of the vacuum-wheel type. A No. 35, 6-blade fan operated at from 1,800 to 2,000 R.P.M. is usually satisfactory.

A damper should be placed in the piping between the unloading fan and the separator (figs. 7 and 8), so that the unloading at the wagon may be stopped without shutting down the fan.

Drying Fan.- A No. 40 or No. 45 standard gin fan may be used to blow the air through the blast coils or heater and thence through the drier. Figure 7 shows this fan at the left end of the drier. This arrangement is called a blow-through system.

If the dried cotton is to be carried directly to the gin, without any receiving bin or other opening, it may be possible to use the regular unloading fan of the gin and dispense with the extra drying fan. Figure 8 shows such an arrangement, which is called a draw-through system. With this system the gin fan must be a No. 45 or larger, and the cabinet, funnel, and piping must be tight so that the fan will draw air through the heater and drier. The cold air at A (fig. 8) is drawn through the blast coils, where it is heated. At B both the dried cotton and the moisture-laden air (still hot) are discharged into the funnel and travel along the piping C to the gin separator. Here the dried cotton is delivered to the distributor E, while the moisture-laden hot air is discharged outside of the gin at D.

Source of Heat.- A 30-HP or larger vertical steam boiler may be used for normal drying work. Pressure should be kept at from 50 to 100 pounds gauge, and the boiler should be well covered for economy of fuel. The blast coils or heater for the drier must be placed about 10 feet higher than the water line of the boiler, so that the condensed steam will drain back to the boiler without need for traps or pumps. A check valve should be put in this return line, and a 1/2-inch vent valve placed at the radiator outlet, so that the heater will not become air-bound.

Air Heater or Blast Coils.- The coils may be home-made of 16 rows of 1-inch pipe, each row having about 14 pipes with return bends, or a commercial heater may be purchased. The fin type of heater, which is manufactured by several concerns, is suggested because it is light, is built in a unit with its casing, and needs only a single supply and return pipe. A 4-foot, 3-row aerofin heater or its equivalent will heat 4,000 cubic feet of air per minute to 180° F., which is about the capacity of a No. 40 gin fan. Such a heater costs (1931) about $200; a 4-row heater costs about $275.

Source of Power.- For the blow-through system, about 30 belt horsepower is needed to run the unloading and the drying fans, the drier conveyors, and the separator.

For the draw-through system, from 15 to 20 belt horsepower is needed, as the drying blast is induced by the main gin fan which is run from another source. A 20-HP motor is suggested, or a tractor may be used for running the unloading fan, the drier conveyors, and the separator.

Figure 6 is a diagram of the shafting and belting lay-out for a blow-through installation. For a draw-through installation, the diagram would omit the drier fan connection. With either system it is desirable to have two speeds for the conveyors of the drier, so that extremely damp cotton may be run through more slowly.

Parts Required.- For a 4-floor, 24-foot drier, the items required ordinarily will be as follows:

1.....Drier cabinet, 48 in. wide by 60 in. high by 24 feet long, inside dimensions, as illustrated (Figs. 1 to 7), sides lined with No. 28 galvanized iron; 4 floors, 15 in. apart, of No. 22 galvanized iron.
1.....Air heater; fin type, three rows of tubes 4 feet long, complete in sheet-iron casing with attachment flanges; or home made as described.
1.....Separator, vacuum wheel type.
1.....Unloading fan, No. 35 size.
1.....Drying fan, No. 40 size (not required in draw-through system).
1.....Boiler, vertical steam, A.S.M.E. code, 100 lbs. working pressure, complete with 30 or 40-ft. stack, etc.
210 feet.....No. 77 plain detachable link chain.
20 feet.....No. 77 right-hand D-5 attachment links.
20 feet.....No. 77 left-hand D-5 attachment links.
8 pairs.....No. 77 coupler links.

50 feet..... No. 88 plain detachable chain for driving both conveyors
1 pair..... No. 88 coupler links.
1 pair..... No. 88 sprockets, 8-tooth, 1-1/2 in. bore, with keyseat, gib key, and set screws.
2..... No. 88 sprockets, 24-tooth, 1-1/2 in. bore, with keyseat, gib key, and set screws.
4..... Shaft assemblies, each consisting of 1 cold-rolled steel shaft 1-1/2 in. dia x 5 ft. 6 in. long, with 2 No. 77 16-tooth sprockets bored 1-1/2 in. and keyseated in line, 2 safety set collars, 2 solid boxes, and 2 take-up boxes size 1-1/2 in. with grease cups.
2..... Jack shafts, each 1-1/2 in. dia x 6ft. 6 in. long, complete with 2 safety collars per shaft and 2 plain or solid boxes per shaft.
160 pieces..... 1/2 in. black pipe cut into plain lengths each 42-1/2 in. long, for carriers on conveyor.
4..... Angle irons for drag rails, 3 x 2 x 3/16 in., each 20 feet long, drilled for nailing with and holes countersunk on inside faces of the angles.
4..... Angle irons for drag rails, 3 x 2 x 3/16 in., each 18 feet 4 in. long, drilled for nailing, holes countersunk on inside faces of angles.

Main drive parts: Pulleys and belts for fans, separators, and jack-shaft drives according to requirements of particular installation. Figure 6 shows pulleys for 2 speeds for the drier, but other combinations may be used.

Construction of Vertical Drier

Drying Cabinet. (Refer to Figs. 9 to 16.) The tall cabinet, rectangular in plan, is referred to as the "tower". (Figs. 9 and 10.) Within it are 13 or more sheet metal floors which may be either hinged or stationary. Hinged floors permit better control over the drying process, but the construction is simpler and the cost is less when stationary floors are used. Figure 11 shows at A, B, and C, respectively, the positions of the hinged floors for drying damp cotton, for drying wet cotton, and for cleaning out the drier.

For a drier with hinged floors, Figure 12 shows the height of the tower posts as 22 ft. 6 inches and the spacing of the 13 floors as 15 inches. Each floor is pivoted on its own axle, and counterbalanced. The figure shows also how the levers are made and connected so that all the floors are operated together. Figure 13 gives the cross-sectional dimensions of the tower, 48 x 62 inches inside.

The top of the tower is covered, except for the 15 x 48-inch opening (A, fig. 9) where the piping hood delivers the hot air and cotton into the drier. The corner posts of the tower may be solid timbers or may be built up of three 2 x 6-inch pieces. (Fig. 13.) Straight posts may be obtained more easily by the built-up method. The tongue and groove siding of the tower should be put on diagonally to give the tower rigidity and strength. The tower is lined with galvanized sheet iron, so as to be air-tight and fireproof. A 1-inch steam line should lead to the top of the drier for use in case of fire.

The floors are of galvanized iron placed upon arms and axles. (For stationary floor construction, see page 9 .) Each floor is hinged to an incline, which is made of galvanized iron on wooden forms which have strap hinges for the floor axle to pass through. Figures 14 and 15 give details of construction for the floors and inclines. The incline forms are covered with the galvanized iron after the floors are installed in the tower, to make a neat junction with the hinged floors. One side of the tower is left off until the floors have been placed in position and hooked up by means of the cranks, operating rods, and slide bar, and have been tested to see that they operate satisfactorily.

It may be desirable, where hinged floors are used, to provide a row of holes down the center of the tower sides, so that 5/8-inch bolts may be plugged into position as supports for the floors when the operation of the drier is brought up to full capacity. The downward pressure of the fan blast, added to the weight of the cotton, may cause the floors to sag. To prevent this, "pegging" of the floors by bolts, which may be removed readily, is suggested.

It is also desirable to provide a screened opening on each face of the tower between the lowest floor and the upper rim of the funnel or hopper. These openings are not indicated on the drawings, and may be of any size from 1 to 2 feet square. They permit wide variation in the capacities of the drying fan and gin fan, and prevent a bottling or corking action within the tower. These openings permit inspection of the drying process and increase the capacity of the drier and free flow of the cotton.

In order that each floor may swing free and yet make a tight joint with the side walls, a strip of cotton woven bellyband is nailed between the sheet metal facing of the floor and its arm. (Fig. 13.) A lip of 1/2 inch should be allowed to hang over the edge of the floor so that the bellyband will wipe smoothly against the side wall of the tower.

For stationary floor construction, 15 floors are used as a rule, the extra travel of the drying cotton making up for lack of adjustment of the floors. The floor arms and incline forms are bolted or nailed to the sides and ends of the tower (fig. 16) and the heavy sheet metal incline and floor surfaces are nailed to them. The discharge end of each floor and the junction between incline and floor are supported upon 2 by 4-inch pieces laid flatwise across the tower to prevent sagging of the sheet metal under heavy loads of cotton. As the floors are spaced 15 inches apart. the tower may be made up of 2 by 8-inch sides and ends laid horizontally, the floors being built in as the tower sides are put on. Removable panels should be installed for each pair of floors, as shown in Figure 16, to give access to the interior for inspection and cleaning.

In operating the drier, both cotton and hot air are blown into the tower at the top. There are no moving parts within the tower. If the floors are hinged, the ginner sets them at the slope he desires (fig.11), and the dried cotton is carried out through the funnel at the base of the tower and thence to the gins. If the cotton is not thoroughly dried in one passage, it should be carried to the overflow floor of the gin and then run through the drier a second time.

Feeding Equipment.-The vertical drier requires a telescope, a separator, an unloading fan, and a hot-blast fan, as shown in Figure 10. These should be run at normal ginning speeds, which are familiar to the trade. The telescope, separator, and unloading fan should be the same as specified for the feeding equipment of the horizontal drier.

Drying Fan.-This should be the same as that specified for the blow-through system of horizontal drier.

Source of Heat.- This should be the same as specified for the horizontal drier.

Air Heater or Blast Coils.-This may be the same as for the horizontal drier, but a 4-row heater is highly desirable.

Source of Power.-About 30 or 35 horsepower is needed to run both the fans and the separator. Figure 10 gives a suggested shafting layout, and Figures 9 and 10 show the installation features.

Parts Required.- The items required for a vertical drier installation are as follows:

1..... Drier cabinet or tower, as illustrated (figs. 9 to 15), with 13 hinged floors counterweighted and operated simultaneously by telescoping levers, or with 15 stationary floors.
1..... Air heater
1..... Separator
1..... Unloading fan
1..... Drying fan
1..... Boiler, vertical steam
Pulleys, belts, and piping according to requirements of particular installation.

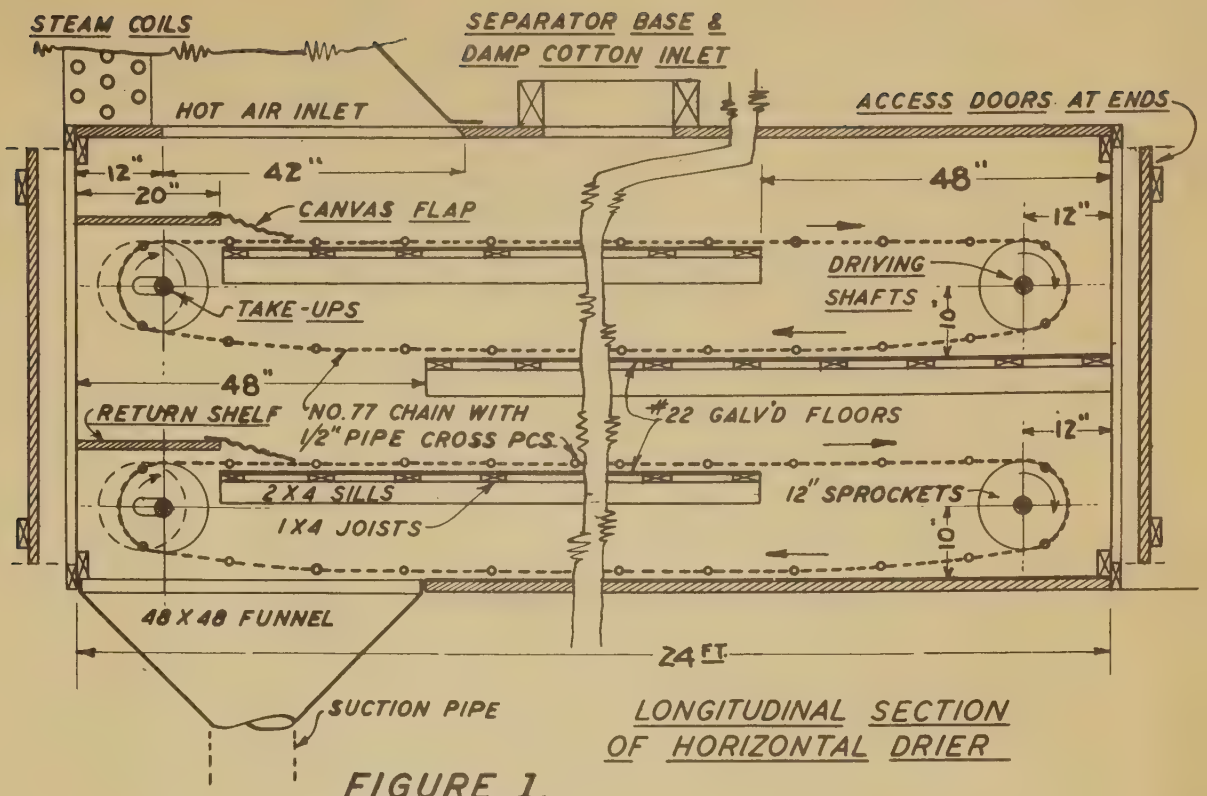


FIGURE 1.

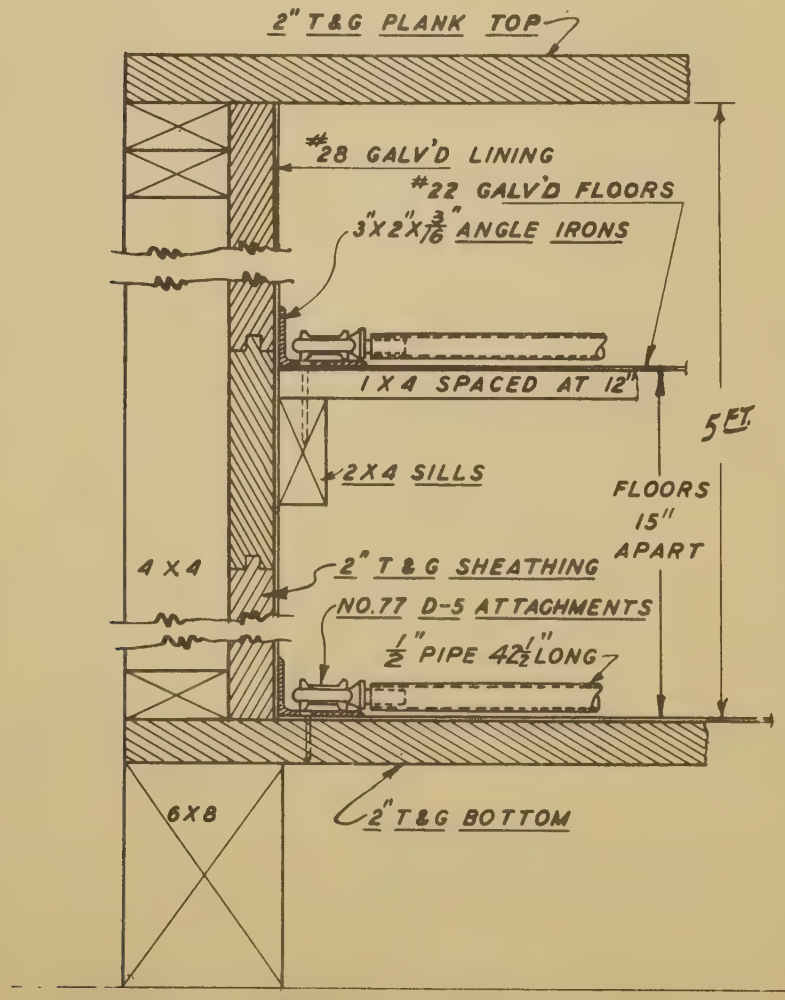


FIGURE 2.

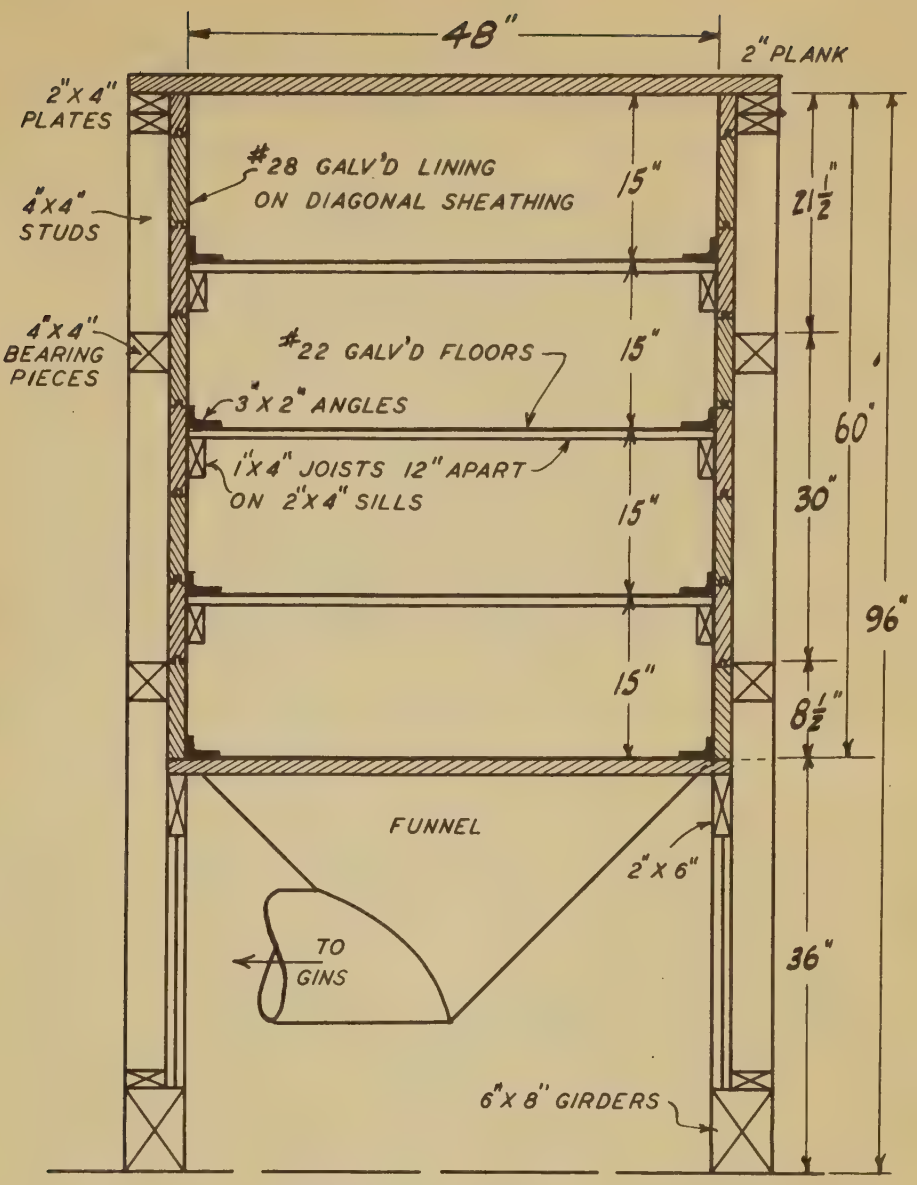


FIG. 3. VERTICAL SECTION OF HORIZONTAL WOODEN DRIER

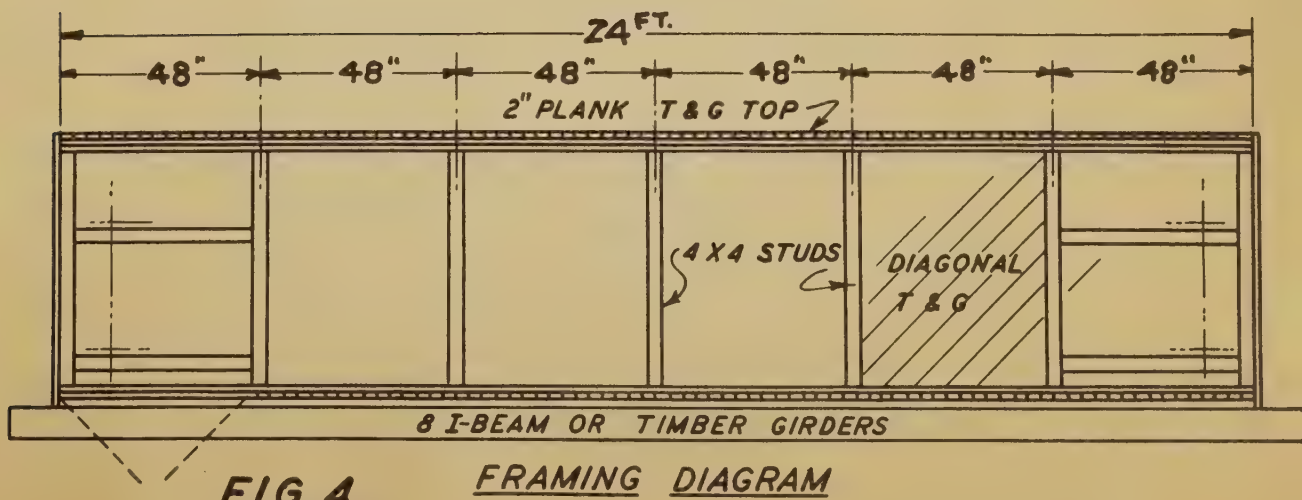
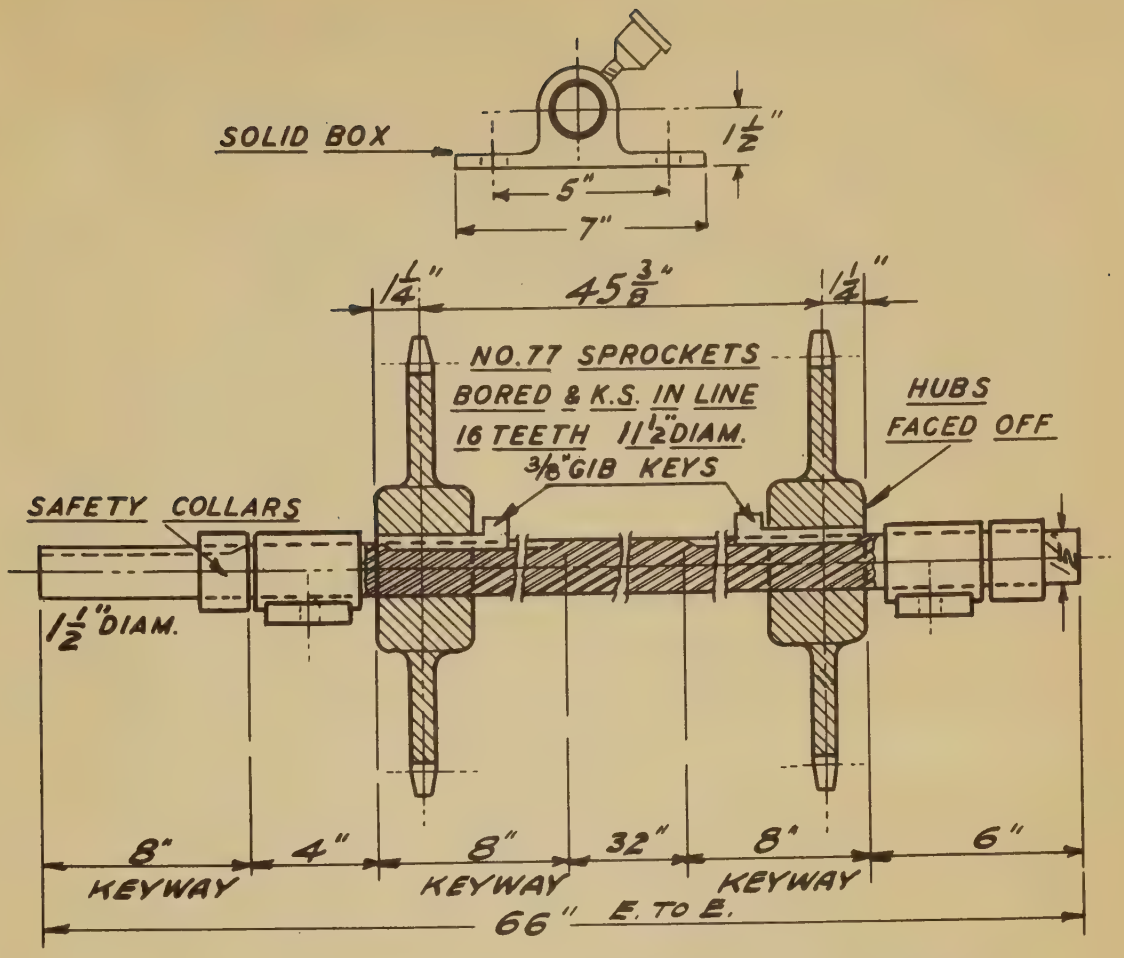
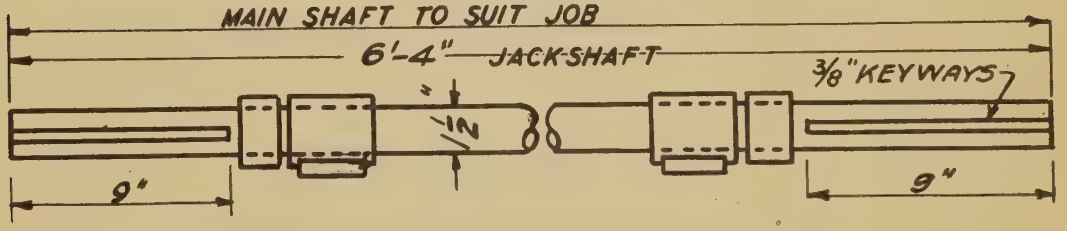


FIG. 4. FRAMING DIAGRAM



C.R. SHAFT ASSEMBLY FOR DRIER

TWO REQUIRED WITH SOLID BOXES ETC. COMPLETE
" " " TAKE-UP " " "



MAIN SHAFT & JACKSHAFT, PULLEYS OMITTED.

FIGURE 5.

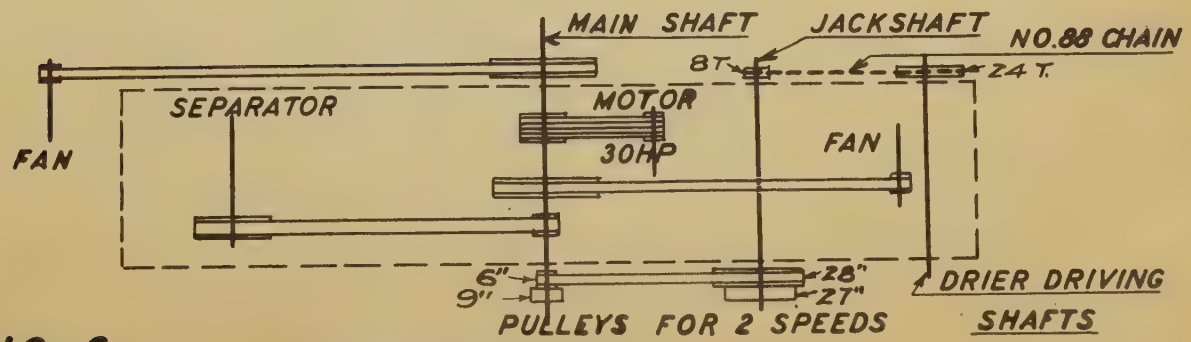
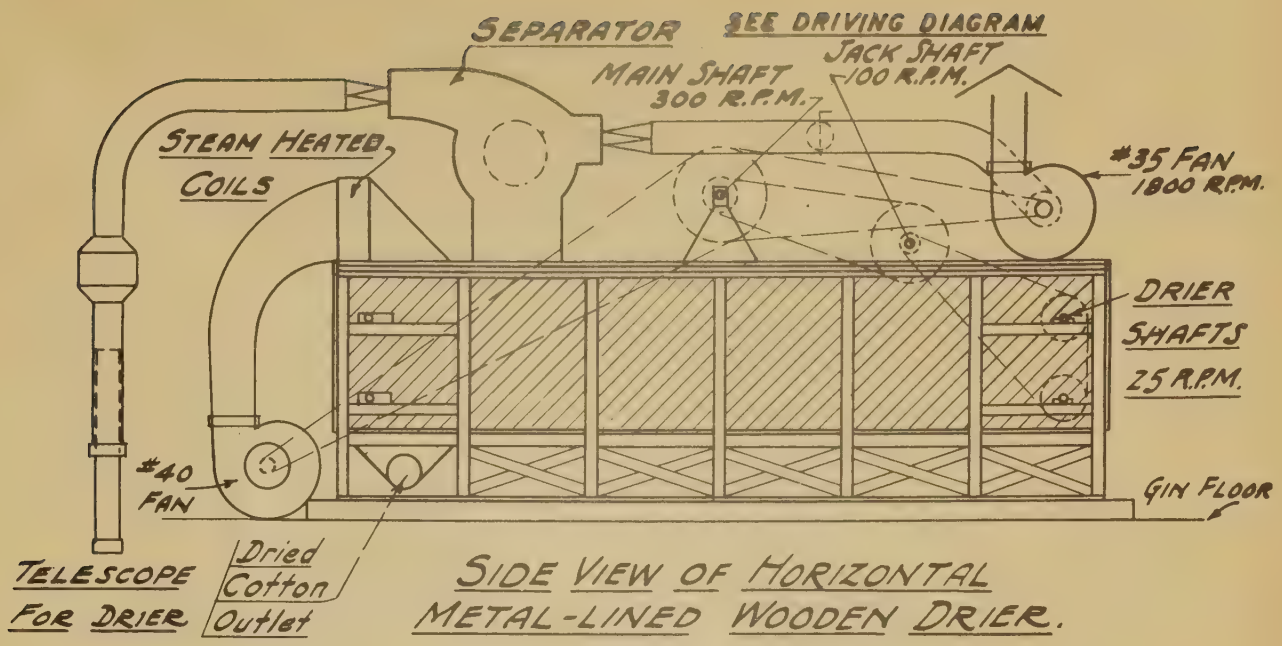


FIG. 6. DRIVING DIAGRAM



SIDE VIEW OF HORIZONTAL METAL-LINED WOODEN DRIER.

CABINET 24 FT. LONG

NOTE: LEGS MAY BE OMITTED

FIGURE 7.

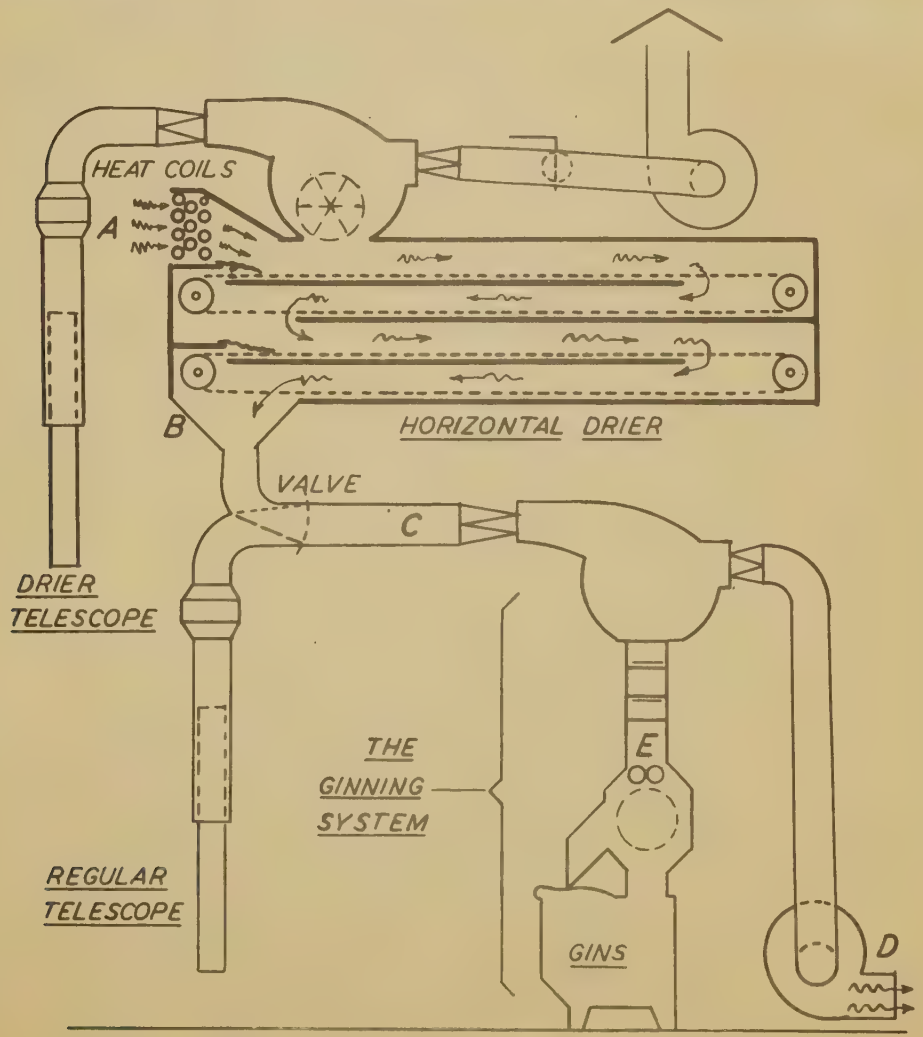


DIAGRAM FOR DRAW-THRU DRYING INSTALLATION

FIG. 8.

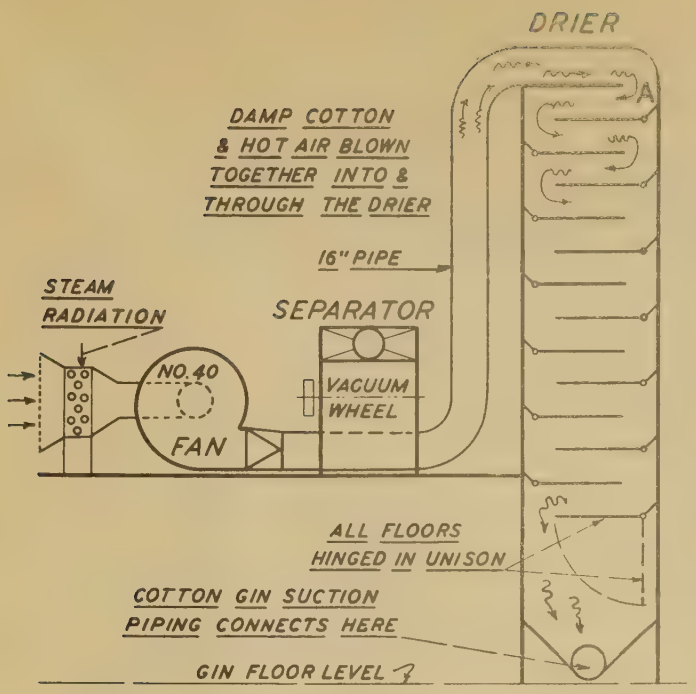


FIGURE 9.
DIAGRAM OF VERTICAL DRIER
SHOWING SECTION THROUGH TOWER

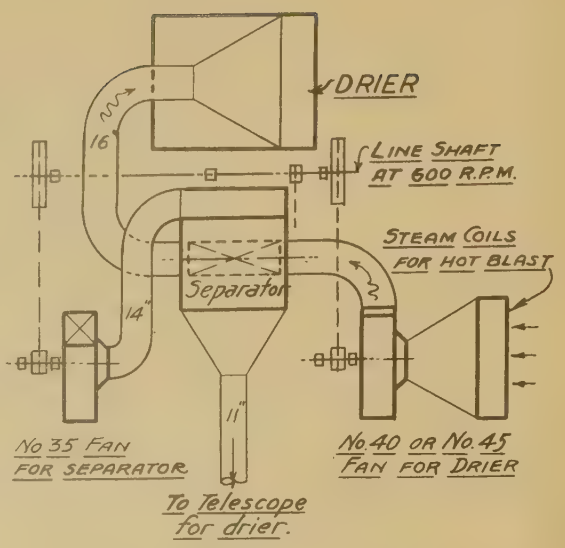


FIGURE 10.
PLAN DIAGRAM OF VERTICAL
DRIER AND PRINCIPAL ITEMS.

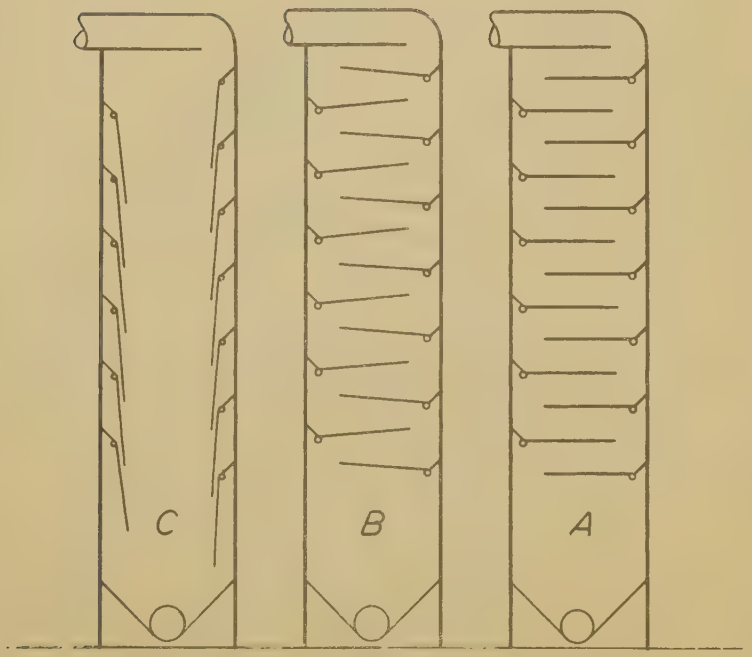
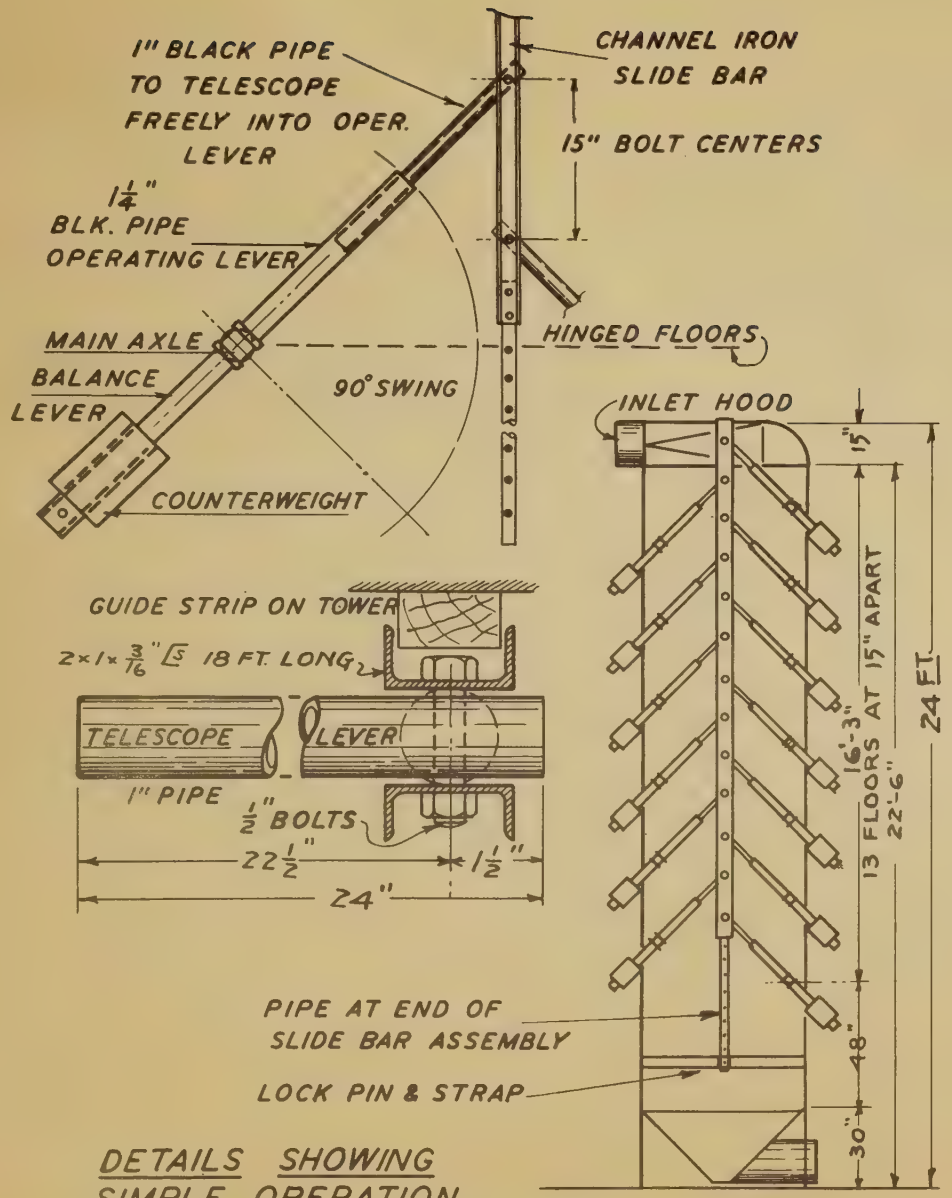
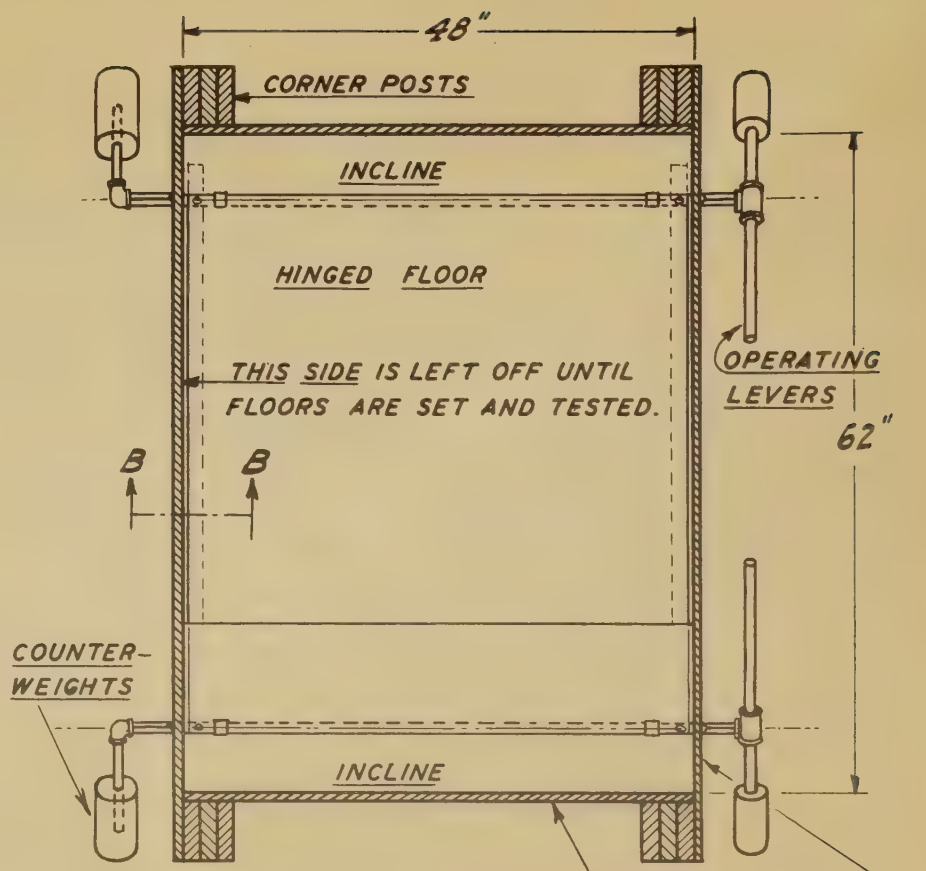


FIGURE 11.
OPERATING POSITIONS OF FLOORS
FOR VERTICAL DRIER.

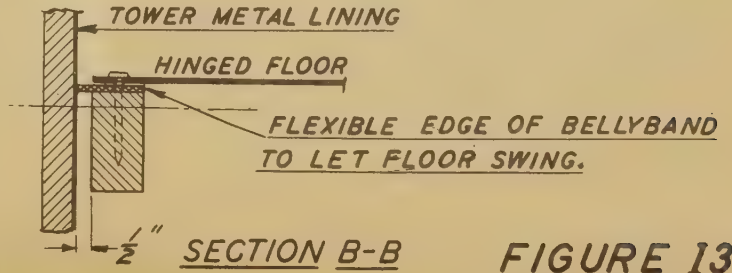


DETAILS SHOWING SIMPLE OPERATION OF HINGED DRYING FLOORS

FIG. 12.



PLAN SECTION OF DRIER TOWER.



SECTION B-B

FIGURE 13.

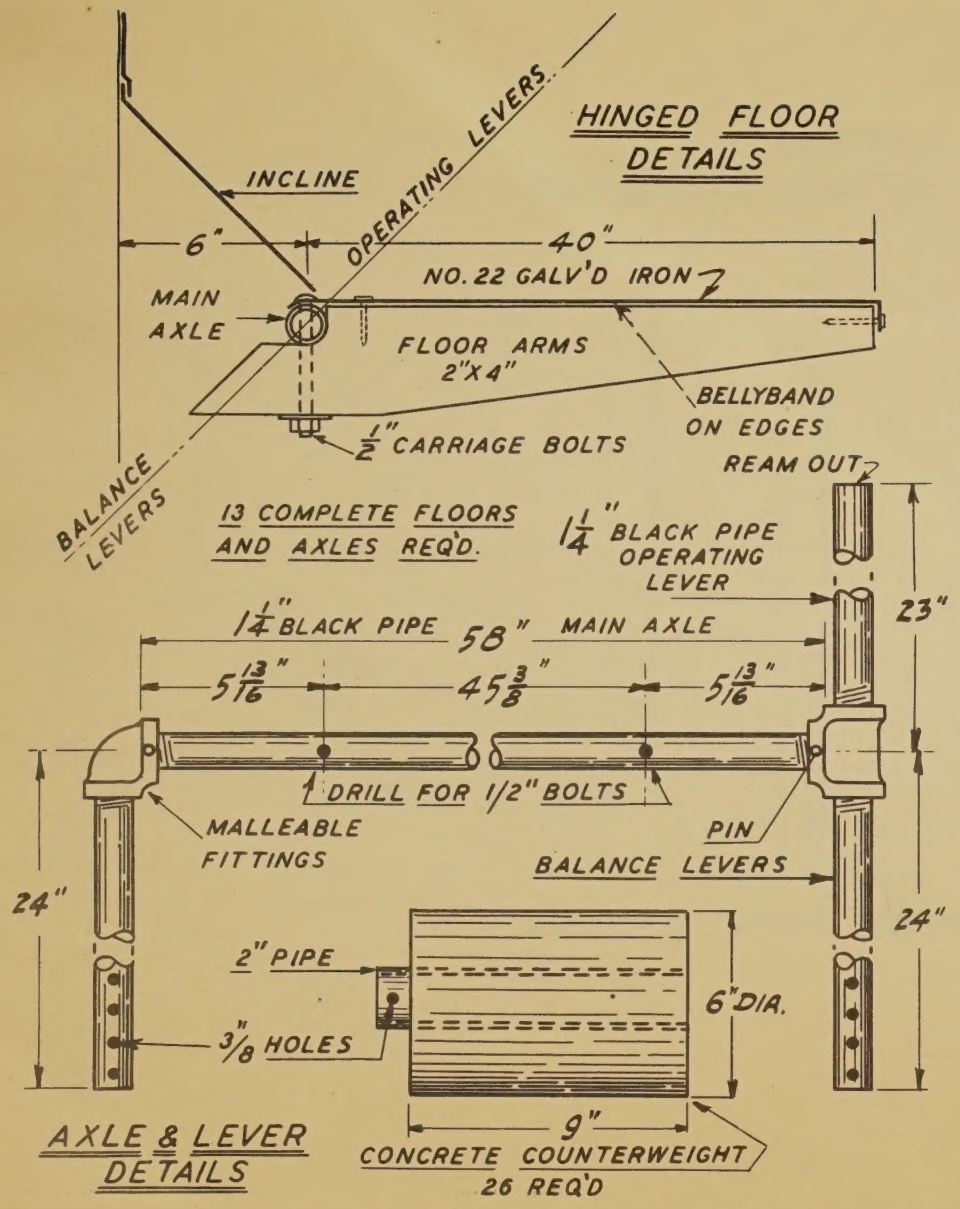
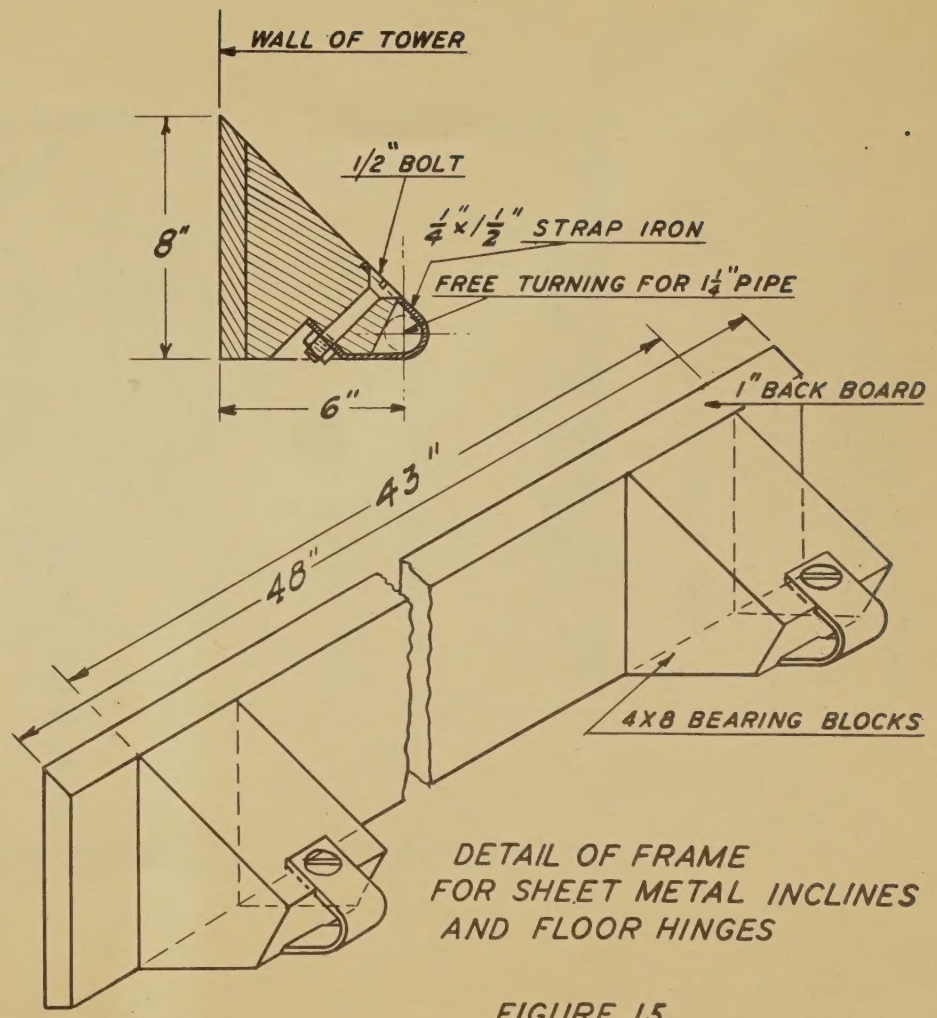


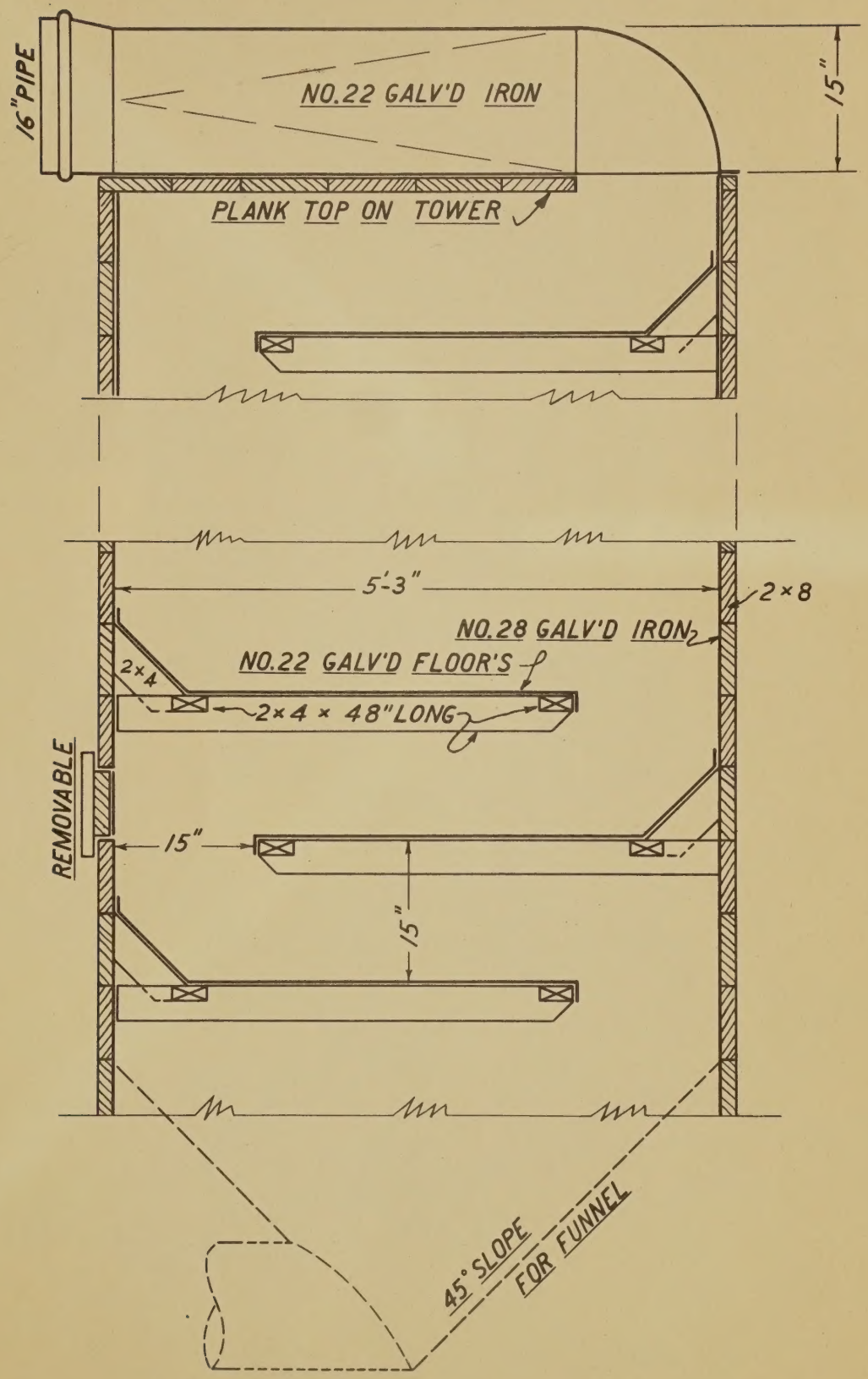
FIG. 14.



DETAIL OF FRAME FOR SHEET METAL INCLINES AND FLOOR HINGES

FIGURE 15.

TINNER TO MAKE SLIDE DOORS
IN TOP INLET FOR ACCESS



STATIONARY FLOOR DETAILS OF VERTICAL DRIER
FIGURE 16.